Information-Based Manufacturing

Program Manager: David C. Stieren
Total FTE: 8
Total Funding: $3,400,000

Goal

To develop competence across NIST in the use of information technology (IT) to aid in the conduct of research, accelerate the development of standards, and improve the delivery of NIST measurement and testing services.

Program Objectives

FY2000

Facilitate on-site and remote collaborations and enable access to geographically distributed resources.

FY2000

Enable and accelerate development of standards for facilitating the interoperability of manufacturing systems and the rapid insertion of new technologies into these integrated systems.

Customer Needs

Significant performance advances in computing, communication, and networking technologies are delivering opportunities for tremendous improvements in manufacturing processes and practices. These technological advances are occurring alongside other equally significant changes that are reshaping the world of manufacturing and business competition: Markets are fragmenting, customer demands are becoming more specialized, and product life cycles are shrinking. The importance of suppliers is growing, accounting for an increasing share of the value-added content of finished products. World-class manufacturing capabilities are sprouting in newly industrializing countries around the globe, while established, export-minded companies are building production facilities close to growing foreign markets.

These and other fluid conditions present major challenges and major opportunities. They also are a prescription for action, as summarized by a representative of the nation's aerospace manufacturing sector:

"We must determine a new way of doing business. In order to succeed in global competition, we need to find a way to accommodate low-rate production . . . affordably. We need to be flexible so that we can build the latest technology and developments into our processes and into our factories to reduce costs. . . . We need to shorten the product development cycle, reduce risks through application of all elements of virtual prototyping, modeling, and simulation with integral cost analyses, and, finally, provide world class quality . . . at the lowest cost."

In all sectors, manufacturers are seeking to identify and develop the fundamental attributes of a successful enterprise that can compete on a global scale. A general conceptual consensus on the hallmarks of future manufacturing competitiveness has emerged. All require capabilities enabled by effective applications of information technology.

Especially critical capabilities include operational and product flexibility, cost-effective product-customization, modularity of equipment and processes, knowledge-based operational and strategic decision making, and integration within and among enterprises.

Companies are not yet fully realizing these capabilities. Major voids still exist in the infrastructure needed to support manufacturing applications of information technology. Without an underpinning foundation of communication protocols, interfaces, and other industry-adopted standards, even companies that are investing large sums in information technology will eventually reach a dead-end. "The use of advanced technologies within our company," an automotive company executive has noted, "will have only a marginal impact on our competitiveness if our supply base does not have access to the same technologies."

Access to these technologies tends to be largely restricted because of the lack of interoperability among competing vendors' systems and subsystems. As pointed out recently by a panel of manufacturing experts, better standards are fundamental to building the technological acumen and capabilities of suppliers and original equipment manufacturers alike, while reducing the costly risk of premature technological obsolescence.

Technical Approach

MEL initiated the Information-Based Manufacturing Program in 1995 to enhance its ability to work with industry in the development of technologies and standards for the U.S. manufacturing community, specifically those manufacturing industries working the discrete, mechanical manufacturing sectors. The program was also initiated to improve MEL's ability to deliver measurement and testing services for industry.

The program's strategy was designed by MEL initially to promote collaborative research across the various MEL Divisions, thus developing competence in the use and exploitation of information technology (IT) for research and measurements and standards activities throughout MEL. As the program evolved, the strategy also evolved to encompass collaborations with other NIST Measurement and Standards Laboratories. This evolution expanded the technical focus to include technologies, measurements, and standards aimed at industrial sectors served by the other NIST Laboratories, beyond those of MEL.

Competence has been developed during the program across all seven NIST Laboratories and the Manufacturing Extension Partnership (MEP) Program to exploit IT in the improvement of:

1. The conduct of manufacturing research performed by NIST for and with American industry
2. The delivery of NIST measurement services
3. The means by which NIST scientists and engineers access the tools and information they need to do their jobs, including equipment, software, other NIST scientists, and non-NIST collaborators

In essence, the program strategy has focused on developing competence across NIST to exploit IT for NIST

- customers
- services
- scientists

Fueled with support from the NIST Director, this program has matured from a set of four inter-division MEL projects, into a collection of sixteen inter-Laboratory projects that exploit the capabilities of high-performance networking and advanced computing technologies. Each of the sixteen projects derives its technical and standards basis from specific core programs and initiatives contained within distinct NIST Laboratories.

The Information-Based Manufacturing program has provided these projects with an advanced information infrastructure enabling access to a collaborative testbed environment where multidisciplinary expertise is leveraged through cross-Lab participation. These elements have combined to put NIST resources on-line across the agency, allowing significant amounts of hardware, software, and staff expertise to be accessible by both NIST customers and NIST scientists. This has successfully promoted the effective and efficient application of these resources to the collaborative conduct of research and the improved delivery of measurement and testing services.

With MEL providing technical and organizational support to all of the projects, the program has successfully demonstrated the beginning of a new era of cross-Laboratory cooperation at NIST. The focus on incorporating IT into projects to leverage resources and foster inter-disciplinary collaboration has significantly improved the way NIST scientists and engineers serve American industry. Furthermore, the program has clearly and successfully demonstrated that NIST is an agency that is fully embracing leading-edge IT to execute its Congressionally-mandated mission of fostering sustained U.S. economic growth by working with industry to develop and apply technology, measurements, and standards.

National Advanced Manufacturing Testbed

A primary resource for enabling this Program's activities has been the National Advanced Manufacturing Testbed (NAMT). The NAMT is a physical testbed built on a state-of-the-art, high-speed computing and communications infrastructure that supports collaborative research among NIST, industry, academia and other government agencies.

The NAMT provides network connectivity and computing support to Program projects. The NAMT provides project participants the ability to connect their research laboratories, equipment, and software into a high-performance network backbone that enables the

simultaneous communication of voice, video, and data information over a single physical medium at high speeds and at guaranteed qualities of service.

The collaborative research and development (R&D) environment supported by the NAMT is similar in many ways to the concepts of a collaboratory. A collaboratory can be considered as a "research center without walls." Within the NAMT collaboratory, various tools and systems that use computing and networking technology to aid manufacturing research are integrated together to provide an environment that allows scientists and engineers to make more efficient use of manufacturing resources, regardless of where they are located.

Accomplishments

- This program is planned for conclusion in FY2000, with individual projects to be continued on a project-by-project basis in conjunction with the objectives of MEL Division programs, or in conjunction with the programs of other NIST Laboratories in those instances where projects are led by other Labs
- September FY2000 The following summarizes the capabilities that have been developed by the program:
  1. The ability to deliver NIST measurement and testing services on-line,
  2. The provision of remote access to NIST equipment and instrumentation used in advanced manufacturing and measurement research,
  3. The use of modeling and simulation to advance research,
  4. The fostering cross-OU collaboration throughout NIST,
  5. The production of traditional R&D program outputs, such as publication of technical papers, delivery of presentations, conduct of workshops, etc.,
  6. The fostering of partnerships with customers of NIST,
  7. The upgrading of NIST networking capabilities through the NAMT, and
  8. The demonstration of technical feasibility and leading-edge capabilities to the industrial public